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Differences in the Texture of Chalk as observed by NMR

Katika, Konstantina; Addassi, Mouadh; Alam, Mohammad Monzurul; Fabricius, Ida Lykke

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Differences in the Texture of Chalk as observed by NMR

Konstantina Katika, Mouadh Adassi, M. Monzurul Alam and Ida Lykke Fabricius

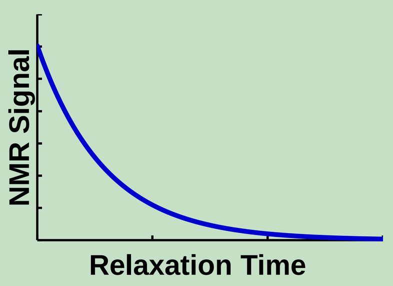
In this study, three cases under investigation illustrate how changes in the surface-to-volume ratio of chalk affect the low-field Nuclear Magnetic Resonance signal:

1. Outcrop chalk saturated with high salinity brine showed that saturation with **divalent ions** can cause major shifts in the T_2 curve.

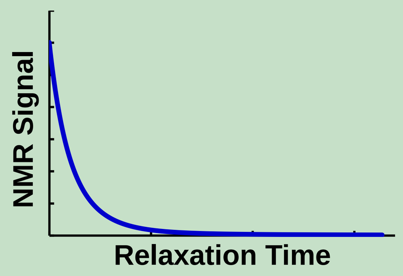
2. Fluid samples where **precipitation** reactions caused shifts in the T_2 curve due to the creation of crystals within the fluid.

3. Two types of chalk with **different surface-to-volume ratio**, saturated with the same brines produced different NMR signals.

- **NMR signal decay time (known as *relaxation*) is affected by the solid phase:**



Long distance from the pore walls means long decay times.



In **smaller distances**, NMR relaxation is affected by the solid.

- **Transverse relaxation rate, $1/T_2$:**

$$\frac{1}{T_2} = \rho\frac{S}{V}$$

ρ: surface relaxivity
S/V: surface-to-volume ratio

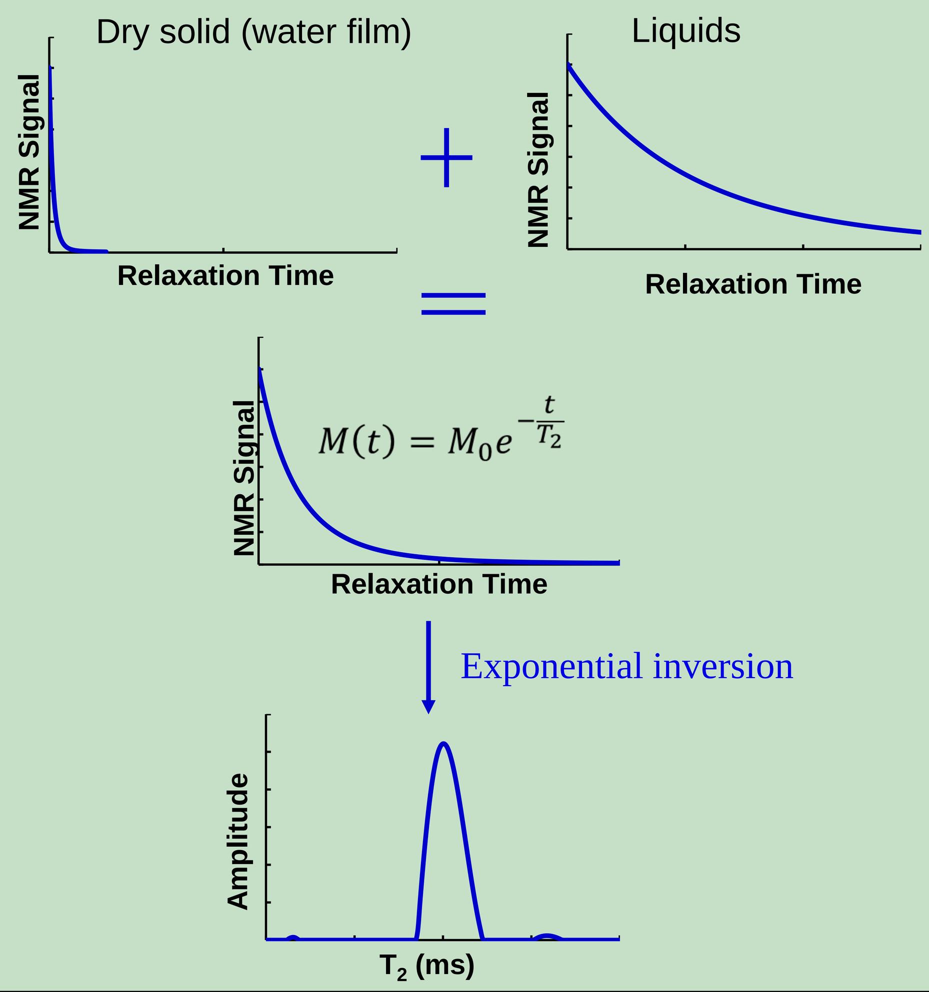
- Differences in the **rock texture**
- **Precipitants** within the pore space
- Variations in the **bound water thickness**

may affect the transverse relaxation time by altering the **surface relaxivity** or the **surface-to-volume ratio** in the following equation:

$$\frac{1}{T_2} = \rho\frac{S}{V}$$

as observed from the following results:

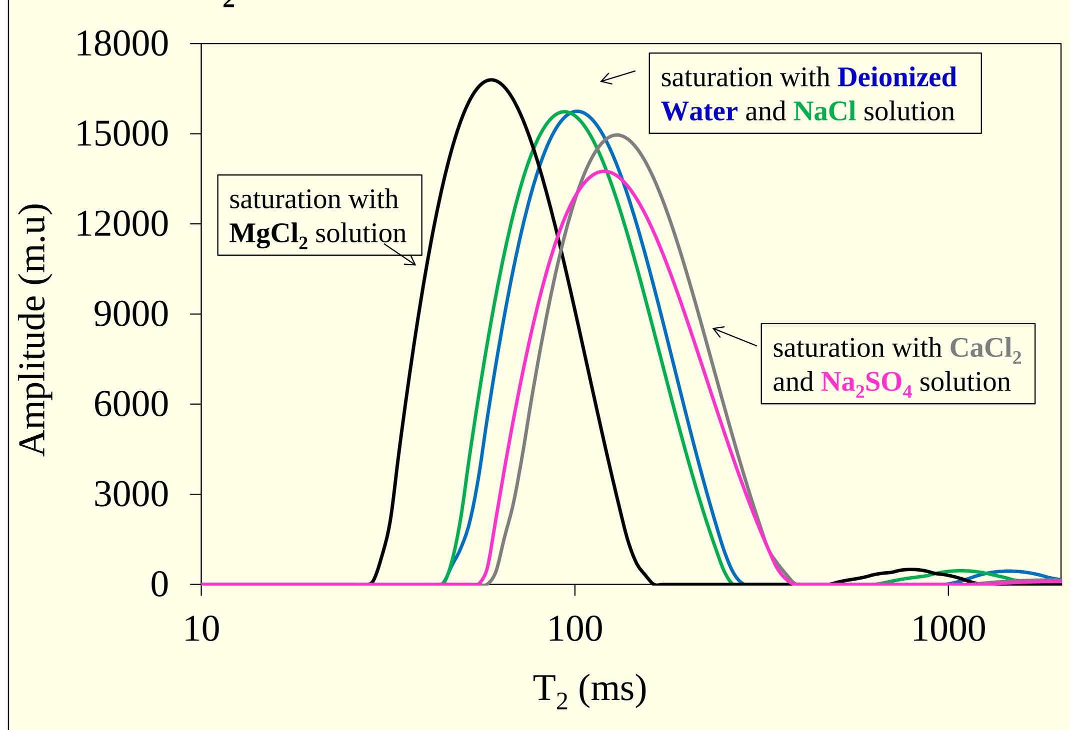
- **NMR Relaxation in the homogenous system of brine saturated chalk:**



- **Outcrop chalk with low surface-to-volume ratio saturated with divalent ions:**

Parameter	ST-Samples
Porosity (%)	~42
Grain density (g/cm^3)	~2.71
Permeability (mD)	~6
Carbonate content (%)	~99
Specific surface (m^2/g)	~1.7
Specific surface of the IR (m^2/g)	~50
Surface relaxivity (μm/s)	~0.9

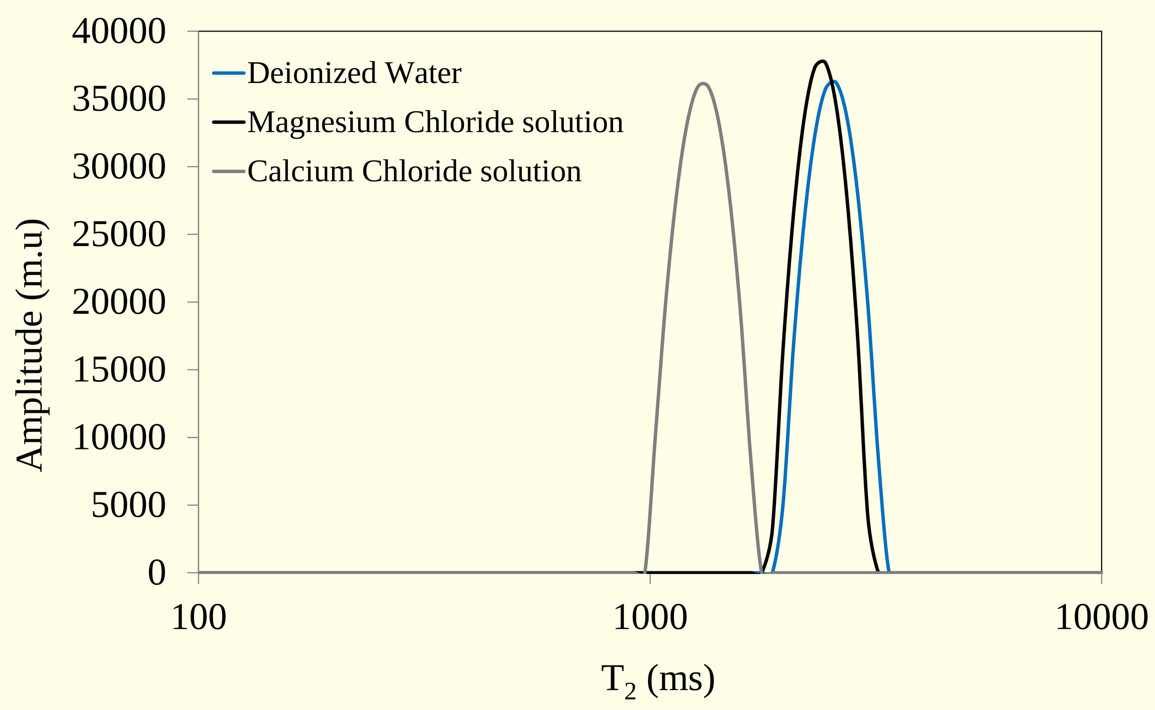
T_2 Distribution of chalk saturated with divalent ions



- **Brines that contain precipitants after contact with chalk:**

Brines with precipitants	Concentration (g/L)
Magnesium chloride solution	58.1
Calcium chloride solution	67.7

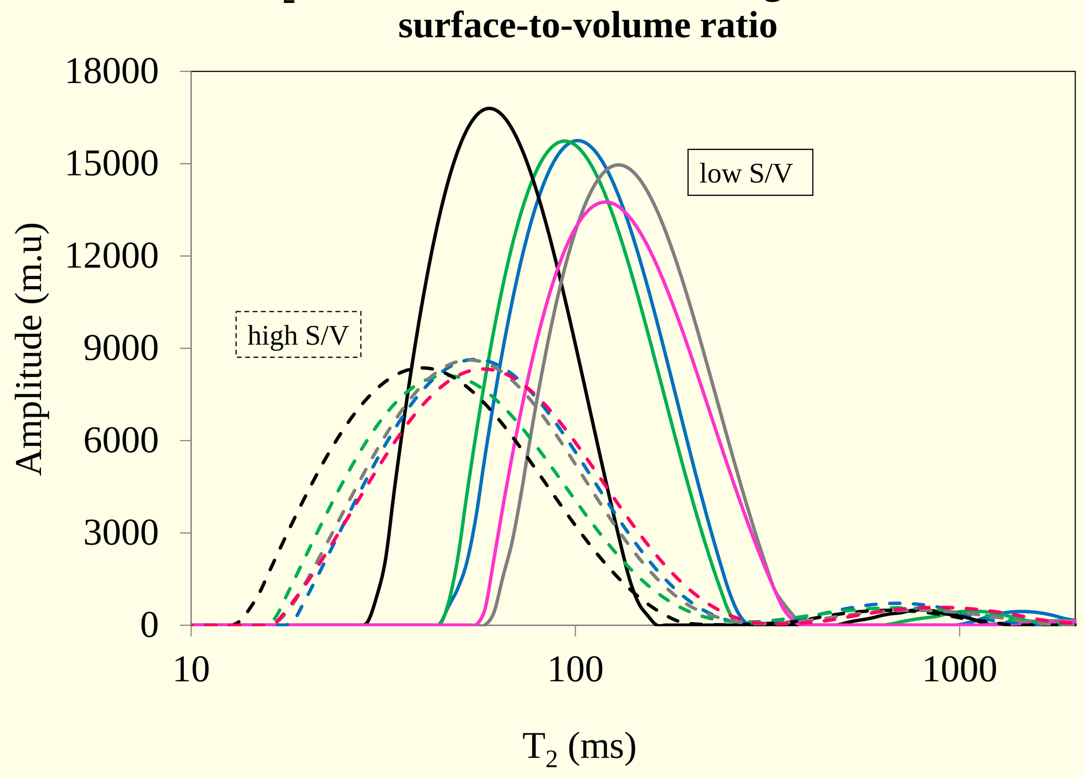
T_2 Distribution of solutions that contain precipitants



- **Outcrop chalk with high surface-to-volume ratio saturated with divalent ions:**

Parameter	MA-Samples
Porosity (%)	~38
Grain density (g/cm^3)	~2.70
Permeability (mD)	~5
Carbonate content (%)	~99
Specific surface (m^2/g)	~1.6
Specific surface of the IR (m^2/g)	~70
Surface relaxivity (μm/s)	~1.5

T_2 Distribution of chalk with high vs. low surface-to-volume ratio



- Low field NMR was successfully used to identify **changes in the surface-to-volume ratio**.
- Samples with **high surface-to-volume ratio result in smaller relaxation times**. Samples saturated with Mg-rich brines, brines containing precipitants, and chalk with different texture illustrate this.

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DTU Civil Engineering
Department of Civil Engineering

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